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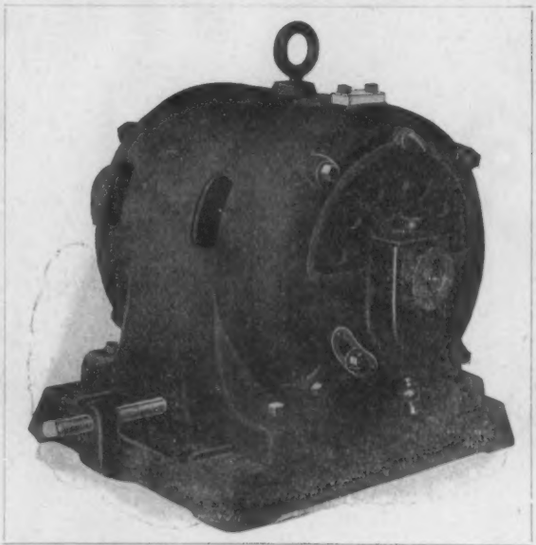

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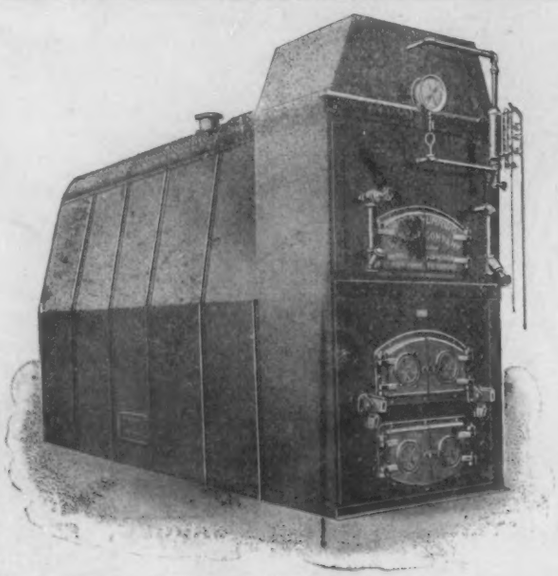

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# Journal of Electricity, Power and Gas

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VOLUME XX. SAN FRANCISCO, CAL., JANUARY 4, 1908 No. 1

## HYDRAULIC SLUICING PLANT.

By J. A. YEATMAN.

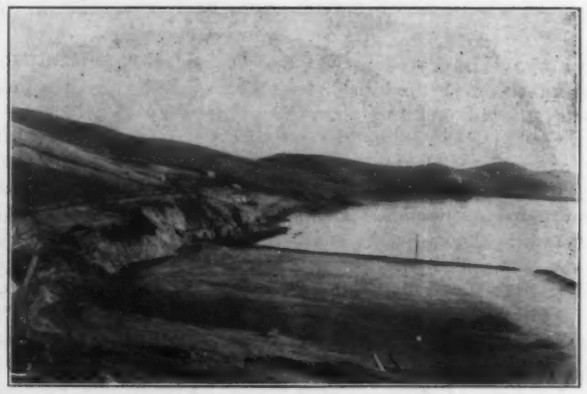
The following description of an original and unique plant for removing the soil over burden in opening a rock quarry may prove helpful to others. About a year ago, the San Pablo Quarry Company, of Oakland, Cal., secured a large acreage for quarry purposes near Richmond, Cal., on San Francisco Bay, and the company was confronted with the problem of removing a deposit of soil and clay ranging from three to twenty feet in depth, covering the faces and levels of the lime rock formation that was to be handled. It was decided the best and cheapest way to remove this soil deposit was to sluice it down to lower level where it would be a benefit, as well as preparing the quarry for active operation.

PRELIMINARY LAY-OUT OF DITCHES

The general contour of the property is shown in the sketch plan herewith and the elevations may be readily noted from the cross section drawing. The work to be performed, consisted of removing the entire soil deposit from the 105 foot level to the top of the hill on the 200 foot level, comprising a strip of ground some 400 feet wide and 700 feet long, averaging about eleven feet deep and containing about 120,000 cubic yards of material. Further, this material was to be transported some 500 feet and deposited within set lines and brought to grade. Being aware that sluice runs on steep grades would carry from fifteen to twenty per cent solid material in solution, it was estimated that to do the work in 100 days it would require a pumping plant having a capacity of about 100 miners' inches of water.

Having decided upon the method and size of the unit, there were still three problems to solve before work could begin. The first was to secure an electric driven pump that would successfully operate through the wide range of varying head conditions; the second was to lay off the hillside so as to get the best results from the giant, and the third was to provide an impounding reservoir for 120,000 cubic yards of material.

The pump was purchased of the United Iron Works of Oakland, Cal., the same to have a capacity of 950 gallons per minute and to operate against a head of 150 to 250 feet without change of capacity while operating at a constant speed of 850 revolutions per minute, and not to require more than 100 horse-power at any time under any set of head conditions between 150 and 250 feet. The pump, a seven inch, twenty-one inch runner, three step pressure type, direct connected to two Westinghouse fifty horse-power, sixty cycle three phase, 440 volt induction motors; one placed on each side of the



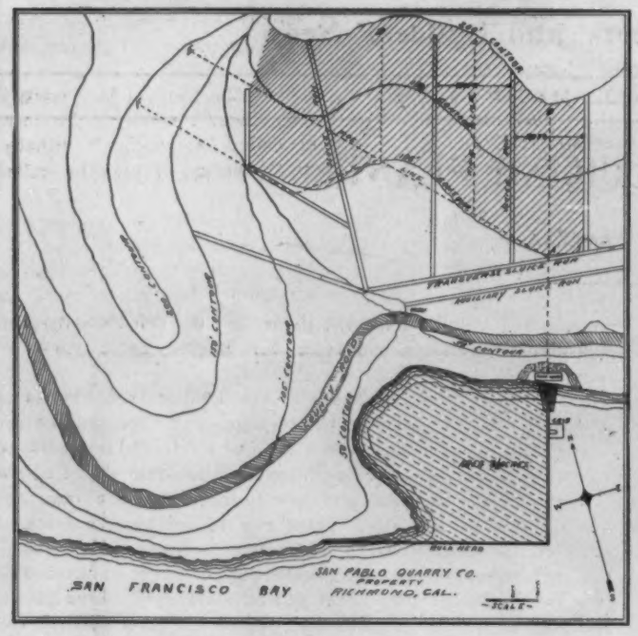
GENERAL VIEW OF WORK DONE

pump and direct connected thereto by means of solid couplings. The pump was fitted with check and relief valve for protection against water ram. The suction was eight inch pipe, 190 feet of which was nearly horizontal, dropping only two feet in this distance, when it turned directly downward into the water fourteen feet, and provided with foot valve to maintain priming. The pump was placed on a prepared shelf on the shore line ten feet above high water, and at low tide the suction head on the pump was eighteen feet when the entrance and pipe losses were added. The discharge pipe line consisting of nine inch riveted and dipped steel slip joint, led directly up the hillside at an angle of about thirty degrees to the giant, which was started on the 105 foot level, as illustrated in cross section and cut showing location of plant.

The plan of operation on the hillside consisted of a number of parallel ditches for sluice runs, placed 150 feet apart, and a transverse ditch leading down the hillside to the impounding bulkheads; an auxiliary ditch was placed some thirty feet below the main transverse ditch as a precaution in the event the working ditch became congested. These ditches were eighteen inches wide and nine inches deep, and made

sure the lines of action. It was not long, however, before they had eroded to bedrock and some places in the main sluice run were fully ten feet deep, and as the clay was so hard, the sides stood almost perpendicular.

The giant played against the face of the soil banks, having




SAN PABLO QUARRY — SECTION OF PROPERTY SHOWING SCHEME OF LAYOUT.

a range of seventy-five feet on each side; when a distance of forty feet up the hillside had been washed away, the pump was stopped and the giant was moved up two lengths of twenty foot slip joint pipe and the operation repeated until the top of the hill was reached. During the last setting of the giant the pressure gauge on the pump would register ninety-seven to 100 pounds. The general plan of the main sluice ditches is shown on the contour plat; the line A B shows the first run of pipe, A C the second and so on. One of the cuts shows the sluice ditches before actual sluicing work began.

For impounding the material washed from the hillside, a bulkhead was constructed; advantage was taken of the natural site, and one line was run southward some 300 feet, and thence at right angles 500 feet to the projecting point, thus enclosing an area of about three and one-half acres. As the part enclosed could be filled to a depth of eighteen feet, it was of ample size to hold all the material to be brought down. It may be noted in illustration, that the surface of the impounded material took a final grade of three feet to 100 and uniformly spread out over the entire area without further attention than providing the site.

In considering the amount of material removed as compared with the amount of water handled, we find that there was 1134 cubic feet of material brought down every hour, and on the basis of 975 gallons per minute, the capacity of the pump, we find that 7800 cubic feet of water was handled

HYDRAULIC GIANT ON 200 FT. LEVEL

per hour. This shows a fifteen per cent solution, which is considered remarkable when it is remembered that a large portion of the ground was so stiff as to require blasting to loosen up the same. The blasting gang is shown in one of the illustrations. The high percentage argues well for capacity, as one cannot well conceive that less water in such material could possibly accomplish so much work.

Work was begun in the early part of September, 1906, and continued regularly until the middle of February, 1907, embracing 120 days actual working time, as revealed by the table, with the exception of the February record.

The table shows the lost and running time the electric current paid for each month, the working head, and the divisions of power as called for by the installations.

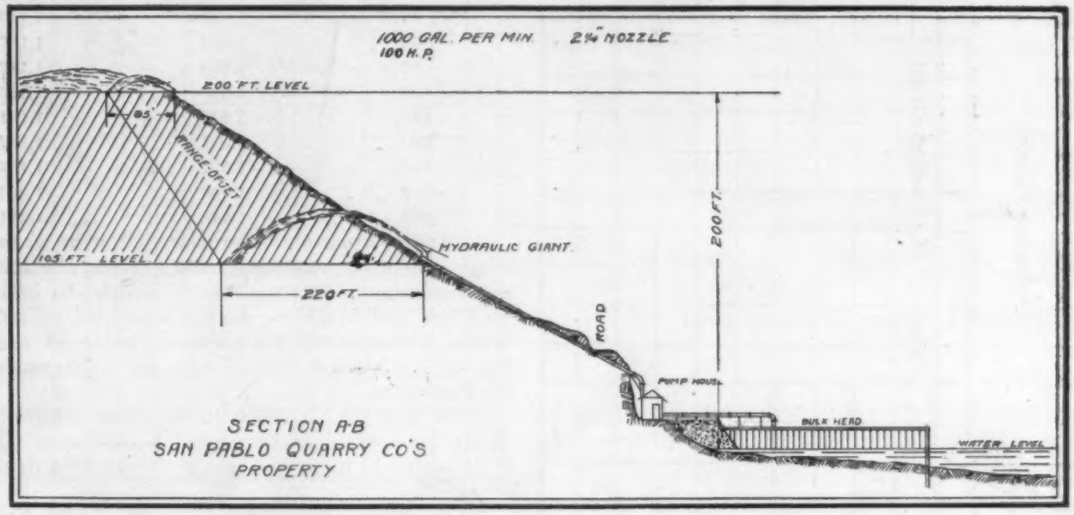
### 7' - 21' 3 STEP UNITED IRON WORKS CENTRIFUGAL PUMP
### direct connected to
### 2-50 H. P. 3 PHASE WESTINGHOUSE CCL MOTORS

| Lost Time . . . . . | Sept. 1906 | | | Oct. 1906 | | | Nov. 1906 | | | Dec. 1906 | | | Jan. 1907 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Repairs . . . . . | Day | Hr. | Min. | Day | Hr. | Min. | Day | Hr. | Min. | Day | Hr. | Min | Day | Hr. | Min. |
| Hydraulics . . . . . | | 80 | 10 | | 1 | 35 | | 5 | 50 | | 113 | 50 | | 56 | 10 |
| Electric . . . . . | | 7 | 35 | | 2 | 20 | | 0 | 30 | | 0 | 40 | | 0 | 00 |
| Low Tide . . . . . | | 27 | 20 | | 112 | 00 | | 137 | 35 | | 117 | 20 | | 125 | 35 |
| No Power . . . . . | | 3 | 40 | | 3 | 10 | | 10 | 20 | | 2 | 35 | | 4 | 45 |
| Moving Giant . . . . . | | 15 | 55 | | 19 | 00 | | 22 | 10 | | 33 | 05 | | 22 | 20 |
| Total Lost Time . . . . . | 6 | 20 | 40 | 5 | 18 | 5 | 7 | 8 | 25 | 11 | 3 | 30 | 8 | 17 | 50 |
| Actual Running Time.... | 16 | 3 | 20 | 25 | 5 | 55 | 22 | 15 | 35 | 19 | 20 | 30 | 22 | 6 | 10 |
| Total K. W. Hours..... | | 29750 | | | 47500 | | | 41130 | | | 33700 | | | 40500 | |
| Average K. W. Del to Trans. . . . . | | 76.8 | | | 78.4 | | | 75.6 | | | 70.7 | | | 75.8 | |
| Average Head Ft. ..... | | 198 | | | 197 | | | 180 | | | 191 | | | 207 | |
| Average H. P. Del. to Line . . . . . | | 97.8 | | | 98.8 | | | 95.2 | | | 89.1 | | | 95.5 | |
| Average H. P. Del. to Motor . . . . . | | 94.9 | | | 95.8 | | | 92.3 | | | 86.4 | | | 92.6 | |
| Average H. P. Del. to Pump . . . . . | | 82.1 | | | 82.9 | | | 79.8 | | | 74.8 | | | 80.1 | |
| H. H. P. Output of Pump | | 50.3 | | | 50.1 | | | 45.9 | | | 48.7 | | | 52.8 | |
| Efficiency Unit . . . . | | 53.0 | | | 52.3 | | | 49.7 | | | 56.4 | | | 57.0 | |
| Efficiency of Pump..... | | 61.3 | | | 60.5 | | | 57.6 | | | 65.1 | | | 65.9 | |

**Remarks.**—December, 1906, broke pump shaft; 97 hours delay.
Efficiency of Transformer, 94 per cent.
Efficiency of Line, 97 per cent.
Efficiency of Motors, 86.5 per cent.
Capacity, 975 Gallons per minute.
Head determined by gauge on pump read every two hours during operation.
Speed, 870 revolutions per minute.

The cost of operation consisted of 220,180 kilowatt-hours at a commercial rate of one and one-half cents per kilowatt-hour would amount to $3,302.70, plus the cost of six men, who handled the giant in two hour turns on eight hour shifts through the twenty-four hours, including a superintendent at a cost of $19 per day for 174 days, would amount to $3303.00, making a cost of five and one-half cents per cubic yard for the material handled. To this should be added the first cost of the plant and the installation, which is estimated at three and one-half cents per cubic yard, making a total net cost of nine cents per cubic yard for the entire material handled.

From an engineering point of view, the above table of performance reveals the following facts: That the average horse-power plant input was 101.5, and that the average losses were as follows: Transformers, six horse-power, line, three horse-power, motors, thirteen horse-power, pump, thirty-one horse-power, or a total of fifty-three horse-power loss against an average of fifty horse-power theoretic work.




A closer examination of the table shows that the pump loss the first month was 31.8 horse-power; second month, 32.8 horse-power; third month, 33.9, or an increasing loss of one horse-power for each month, while the loss for the fourth month was only 26.1 horsepower. This difference of five or six horse-power loss was probably due to the brake action of imperfect alignment and hydraulic leak caused thereby, for when the new shaft was put in, it is observed the operative conditions were much improved. This shows a loss of something less than nine horse-power for each runner of the three embraced in the pump, which is considered normal loss for a single pump runner when handling fresh water. What loss was incurred by the incrustation on the cast iron runners caused by the salt water is problematical. That it was considerable is manifest, as an examination of the runners a short time after they were put in operation shows that the incrustation was about one-sixteenth of an inch in thickness, and the entire surfaces of the runners were very rough.

Another feature worthy of note from this record is continuous performance, is the uniform loading under a variable head condition, as manifest from an examination of the illustrations herewith showing the work done. The average pumping head is quite uniform and remarkable considering the actual varying location of the giant, and can only be explained by the uniform constant capacity of the pump.

## ENERGY TRANSFORMATIONS FROM THE ELECTRICAL ENGINEERS' STANDPOINT.*

By H. M. Hobart.

Electrical engineers are chiefly concerned with three forms of energy, namely: heat energy, electrical energy, and mechanical energy.

When energy manifests itself in the form of heat energy, it is convenient to call it briefly "heat"; when in the form of electrical energy, it may be called "electricity." Finally, when in the form of mechanical energy, it may be called "work."

Unit of Energy—The quantity of energy when in any of these forms, may be expressed in kilowatt-hours.

Kilowatt-Hour—The most frequently occurring occasions when we must express energy quantitatively are those on which it is being transformed from one kind into another, as, for instance, from electricity into heat. The kilowatt-hour is one thousand watt-hours. The watt-hour is the quantity of electricity which is transformed into heat in a wire of one-ohm resistance when a current of one ampere flows through it for one hour. As a potential difference of one volt is required to produce a current of one ampere in a circuit of one-ohm resistance, one watt-hour is equal to one volt-ampere hour for continuous current or alternating current at unity power-factor. It is, however, to be noted that in heavy electrical engineering the watt-hour is an inconveniently small quantity and the kilowatt-hour is more convenient, and is thus taken as the unit of energy.

In the illustrative examples which are to follow, it will appear that even the kilowatt-hour is often an inconveniently small unit, for in some departments of heavy electrical engineering, undertakings involving millions of kilowatt-hours are dealt with.

It has been customary in England to denote this quantity of electrical energy as one "Board of Trade Unit," since it is a unit which has been officially adopted by the British Board of Trade, and it is still frequently expressed in this way. It is, however, more often expressed as one kilowatt-hour.

When no ambiguity is thereby introduced, it is often customary briefly to designate this quantity of energy as one "unit"; but this course is not to be recommended, as the term "unit" should be reserved for use in its more general sense.

In this article the following terms are used in dealing with quantities of energy:

*Electrical Review.

1 watt-hour.

1 kilowatt-hour = 1,000 watt-hours.

Weight and Volume—The weight of one cubic meter of water at a temperature of four degrees is termed one ton.

1 ton = weight of one cubic meter of water.

1 ton = weight of 1,000 cubic decimeters of water.

1 ton = weight of 1,000 liters of water.

1 ton = 1,000 kilogrammes.

1 ton = 1,000,000 grammes.

Pressure—The unit of pressure is one kilogramme per square centimeter. When not otherwise expressly stated, absolute pressures are to be understood. That is to say, pressures are referred to an absolute vacuum and not to atmospheric pressure.

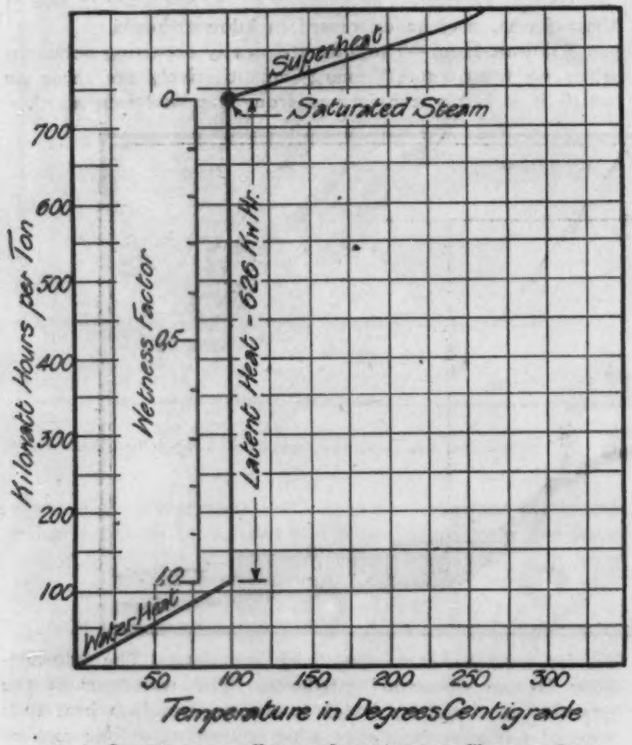



FIG. 1.—RELATION BETWEEN HEAT AND TEMPERATURE FOR WATER AND STEAM AT ATMOSPHERIC PRESSURE.

### Relation Between Heat and Temperature.

The relation between heat and temperature for water and steam may be illustrated by means of the curves in Fig. 1, which represent the occurrences attending the absorption of energy by one ton of water, i. e., the "heating" of one ton of water. During the entire operation, the specific pressure is maintained constant at one kilogramme. The curve consists of three distinct portions. The first portion, marked "Water Heat," slopes upward. The second portion, marked "Latent Heat," is vertical. The third portion, which is marked "Superheat," is slightly curved, but its general character is very similar to that of the first portion.

The first portion of the curve represents the heating of water at atmospheric pressure. For all practical purposes the line is straight, since the rise in temperature is closely proportional to the heat added.

A consideration of the extent of the deviation from a straight line must necessarily be prefaced by a discussion of the "Specific Heat." The meaning of the term "Specific Heat" may be illustrated by an example: At eighty degrees, 1,172 kilowatt-hours are required to raise the temperature of one ton of water by one degree. The corresponding amount of energy required to raise by one degree the temperature of one ton of water at zero degrees is only 1,160 kilowatt-hours. The specific heat of water at eighty degrees is obtained by dividing 1,172 by 1,160, and is consequently equal to 1.010. The quantity of energy, 1,160 kilowatt-hours, which is absorbed in raising the temperature of one ton of water from zero degrees to one degree is the standard of reference as regards specific heat, since water at zero degrees has been chosen as the standard substance, and its specific heat at that temperature is taken as unity.

The specific heat of any body at any temperature is obtained in the above manner by dividing the kilowatt-hours required to cause a rise of temperature of one degree by 1,160, as this is the energy in kilowatt-hours required to raise one ton of water at zero degrees by one degree.

The values of the specific heat of water at various temperatures are given in Table I.

TABLE I.

**The Specific Heat of Water at Various Temperatures.**

| Temperature in Degrees Centigrade. | Specific Heat | Energy in Kilowatt-Hours Required to Raise One Ton of Water by One Degree Centigrade |
|---|---|---|
| 0 | 1.000 | 1,160 |
| 20 | 1.001 | 1,161 |
| 40 | 1.003 | 1,163 |
| 60 | 1.006 | 1,167 |
| 80 | 1.010 | 1,172 |
| 100 | 1.013 | 1,175 |
| 120 | 1.018 | 1,181 |
| 140 | 1.023 | 1,187 |
| 160 | 1.029 | 1,193 |
| 180 | 1.036 | 1,202 |
| 200 | 1.044 | 1,211 |

When at atmospheric pressure a ton of water has been brought to a temperature of 100 degrees, the absorption of additional energy does not cause a further rise in temperature until this additional energy has amounted to 580 kilowatt-hours. Consequently the second portion of the curve in Fig. 1 is a vertical line of a length corresponding to 626 kilowatt-hours.

The heat thus required to be added before any further rise in temperature is occasioned is called the "latent heat" of the water, or the latent heat of vaporization or evaporation of water.

The energy corresponding to the latent heat may be divided into two components. The first component represents the energy necessary to change the molecular state, and is termed the internal latent heat. The second component represents the energy required to expand the water against the surrounding pressure from its liquid volume to its gaseous volume, i. e., to its volume when converted into steam. This component is much smaller than the first component. It is termed the external latent heat, and ranges, according to the specific pressure, from six per cent to ten per cent of the total latent heat.

If, instead of atmospheric pressure, other pressures are maintained during the conversion of one ton of water into steam, the latent heat, as well as its two components, has other values. These are given in Table II for a number of different pressures. In the second column of the table are given the corresponding temperatures at which vaporization occurs.

TABLE II.

**Table of the Internal and the External Latent Heat of Vaporization of Water.**

| Absolute Pressure in Kg. per Sq. Cm. | Temperature of Vaporization in Degrees Centigrade. | Latent Heat of Vaporization in Kilowatt-Hours per Ton. | | |
|---|---|---|---|---|
| | | Internal. | External. | Total. |
| 1 | 99 | 579 | 47 | 626 |
| 2 | 120 | 563 | 49 | 612 |
| 4 | 143 | 541 | 51 | 592 |
| 8 | 170 | 518 | 53 | 571 |
| 12 | 187 | 502 | 54 | 556 |
| 16 | 200 | 487 | 55 | 542 |
| 20 | 211 | 475 | 56 | 531 |

Prior to the absorption by the ton of water at vaporization temperature, of the entire amount of energy correspond-

ing to its latent heat, the ton of water will not have been converted entirely into steam, but will be a mixture of water and steam. At atmospheric pressure the latent heat of one ton of steam is 626 kilowatt-hours. When only half of this quantity of energy, i. e., when only 313 kilowatt-hours have been absorbed, we shall have a mixture consisting of 0.5 ton of water and 0.5 ton of steam. To the diagram in Fig. 1 has been added a scale showing the "wetness" of the steam at various stages of the process of imparting 626 kilowatt-hours to the ton of water. At the commencement of the

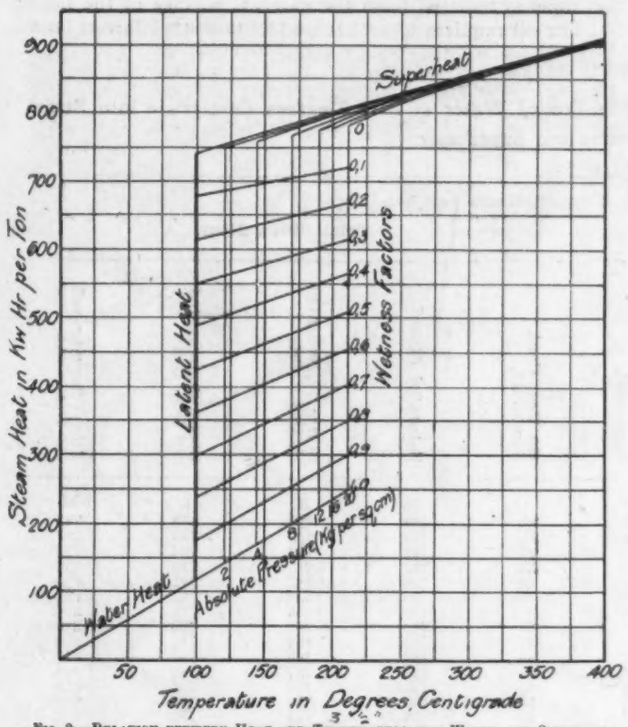



FIG 2.—RELATION BETWEEN HEAT AND TEMPERATURE FOR WATER AND STEAM AT VARIOUS PRESSURES.

process the "wetness" is 100 per cent, or we may say that the steam has a wetness factor of 1.00. When 125 kilowatt-hours have been absorbed the wetness factor is 0.80, and when the entire 626 kilowatt hours have been absorbed, the wetness factor is 0.00 and we have so-called "saturated" steam.

Further additions of heat are accompanied by increase of temperature, and the steam is said to be "superheated." This part of the process corresponds to the right-hand sloping portion of the diagram in Fig. 1. The angle at which this portion of the diagram slopes upward is dependent upon the specific heat of superheated steam.

The specific heat of superheated steam varies considerably with the temperature and pressure. It is, roughly, about half of that of water. Hence a given quantity of energy imparted to a ton of steam will raise its temperature through about twice as many degrees as the same amount of energy imparted to one ton of water.

These data are embodied in the diagrams in Fig. 2, where are drawn, for various pressures, a set of lines corresponding to those already given in Fig. 1 for an absolute pressure of one kilogramme per square centimeter.

The leading properties of steam are entered up in Tables V, VII and VIII. At the present time considerable difference of opinion exists among physicists with regard to the values of the specific heat of superheated steam at various temperatures and pressures. The values employed in the construction of Tables V, VII and VIII are in accord with those given by Mollier in his brochure entitled "Neue Tabellen und Diagramme fur Wasserdampf."

Mollier's values for the specific heat of steam are given in Table III. The values given in this table represent the average specific heat while the temperature of the steam is raised from the temperature of vaporization to various final temperatures.

The specific heat and specific gravity of some common materials are given, together with the kilowatt-hour per ton per degree centimeter temperature rise, in Table IV.

**Examples of the Amount of Energy Represented by One Kilowatt-Hour.**

1. One kilowatt-hour is sufficient to lift one ton through a height of 367 meters.

2. One kilowatt-hour is consumed at the trolley in propelling a ten-ton tram-car of good design on a good and level track for a distance of from one to two kilometers or thereabouts (according to the number of stops per mile), at a schedule speed of some twelve kilometers per hour.

3. One kilowatt-hour is absorbed in eighty-four hours by a twelve-candlepower lamp requiring one watt per candlepower. If the lamp is only in circuit for an average period of four hours per day, 17.4 kilowatt-hours will be absorbed by the lamp in the course of one year, provided that it survives for 1,660 hours in circuit with an average efficiency of one watt per candlepower and that its candlepower does not alter.

If the charge is six cents per kilowatt-hour, the cost of energy for this lamp will amount to $(1{,}660\times6)=104$ cents for the year. Replacing the lamp once a year at a cost of forty-eight cents brings the total annual outlay per lamp to

$$\$1.04+0.48=\$1.52.$$

To this must also be added an equitable proportion of the meter rental. On these assumptions the lamp thus costs a matter of $1.60 per year.

4. The latent heat of liquefaction of ice is ninety-three kilowatt-hours per ton; that is to say, to convert one ton of ice at zero degrees into one ton of water at zero degrees requires the application of ninety-three kilowatt-hours.

TABLE III.

**Table of the Average Specific Heat of Steam Heated from the Temperature of Vaporization at Various Final Temperatures**

| Absolute Pressure in Kg. per Sq. Cm. | | 0.1 | 0.5 | 1 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temperature of Vaporization in Deg. Cent. | | 46 | 81 | 99 | 120 | 143 | 158 | 170 | 179 | 187 | 194 | 200 |
| Final Temperature of Steam in Deg. Cent. | 100 | 0.480 | 0.490 | 0.501 | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| | 150 | 0.479 | 0.488 | 0.495 | 0.513 | 0.533 | ..... | ..... | ..... | ..... | ..... | ..... |
| | 200 | 0.479 | 0.486 | 0.491 | 0.505 | 0.523 | 0.538 | 0.558 | 0.573 | 0.588 | 0.601 | ..... |
| | 250 | 0.479 | 0.484 | 0.489 | 0.500 | 0.514 | 0.528 | 0.543 | 0.556 | 0.569 | 0.578 | 0.588 |
| | 300 | 0.479 | 0.483 | 0.487 | 0.496 | 0.508 | 0.519 | 0.531 | 0.541 | 0.551 | 0.562 | 0.569 |
| | 350 | 0.479 | 0.482 | 0.485 | 0.493 | 0.503 | 0.513 | 0.522 | 0.531 | 0.539 | 0.547 | 0.555 |
| | 400 | 0.478 | 0.482 | 0.484 | 0.491 | 0.500 | 0.508 | 0.517 | 0.523 | 0.531 | 0.538 | 0.545 |
| | 450 | 0.478 | 0.482 | 0.483 | 0.489 | 0.497 | 0.505 | 0.513 | 0.519 | 0.525 | 0.531 | 0.537 |

TABLE IV.

| Material, | Specific Gravity (Tons per Cu. M.) | Specific Heat. | Kilowatt-Hours Required to Raise the Temperature of One Ton by One Degree. |
|---|---|---|---|
| Water ..... | 1.0 | 1.0 | 1.16 |
| Ice ..... | 0.93 | 0.49 | 0.57 |
| Coal ..... | 1.3 | 0.24 | 0.28 |
| Wrought Iron .... | 7.7 | 0.11 | 0.13 |
| Cast Iron ..... | 7.2 | 0.13 | 0.15 |
| Copper ..... | 8.9 | 0.10 | 0.12 |
| Lead ..... | 11.4 | 0.03 | 0.035 |
| Zinc ..... | 6.9 | 0.09 | 0.11 |
| Transformer Oil.. | 0.9 | 0.75 | 0.97 |

this amount being accounted for as follows: As in Example 5, 97.6 kilowatt-hours are required to change the ice into water at zero degrees, and a further 9.3 kilowatt-hours to raise the temperature of the water to eight degrees.

7. The average specific heat of transformer oil is 0.75, of copper 0.1, of iron 0.11. In a certain transformer the weight of the copper is 100 kilogrammes, the laminations 200 kilogrammes, the cast-iron case 150 kilogrammes, and the oil 180 kilogrammes. The internal loss amounts to one kilowatt and it is required to find the time required to cause a rise of temperature of forty degrees, assuming that the heat is exclusively employed in causing a rise of temperature and that none is radiated from the external surface of the frame.

The oil requires $0.75 \times 1.16 \times 0.18 \times 40 = 6.3$ kilowatt-hours.

TABLE V.

**Table of the Energy in Kilowatt-Hours Required to Convert One Ton of Water at Zero Degrees Centigrade into Steam at Various Pressures and Superheats.**

| | | Heat in Kilowatt-Hours per Ton. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Component Parts. | | | | | Total Steam Heat. | | | |
| Absolute Pressure in Kg. per Sq. Cm. | Temperature of Vaporization in Deg. Cent. | Water Heat. | Latent Heat. | 50 Deg. Cent. Superheat. | 100 Deg. Cent. Superheat. | 150 Deg. Cent. Superheat. | Saturated Steam. | Steam Superheated 50 Deg. Cent. | Steam Superheated 100 Deg. Cent. | Steam Superheated 150 Deg. Cent. |
| A | B | C | D | E | F | G | H | K | L | M |
| 0.02 | 17 | 20 | 680 | 28 | 55 | 83 | 700 | 728 | 755 | 783 |
| 0.04 | 29 | 32 | 670 | 28 | 55 | 83 | 704 | 732 | 759 | 787 |
| 0.06 | 36 | 42 | 667 | 28 | 55 | 83 | 709 | 737 | 764 | 792 |
| 0.08 | 41 | 48 | 665 | 28 | 55 | 83 | 713 | 741 | 768 | 796 |
| 0.10 | 46 | 53 | 663 | 28 | 55 | 83 | 716 | 744 | 771 | 799 |
| 0.12 | 49 | 57 | 660 | 28 | 56 | 84 | 717 | 745 | 773 | 801 |
| 0.15 | 54 | 63 | 657 | 28 | 56 | 84 | 720 | 748 | 776 | 804 |
| 0.20 | 60 | 70 | 654 | 28 | 56 | 84 | 724 | 752 | 780 | 808 |
| 0.25 | 65 | 75 | 650 | 28 | 56 | 85 | 725 | 753 | 781 | 810 |
| 0.30 | 69 | 80 | 647 | 28 | 56 | 85 | 727 | 755 | 783 | 812 |
| 0.35 | 72 | 84 | 645 | 28 | 56 | 85 | 729 | 757 | 785 | 814 |
| 0.40 | 76 | 88 | 642 | 28 | 56 | 85 | 730 | 758 | 786 | 815 |
| 0.50 | 81 | 94 | 639 | 28 | 56 | 85 | 733 | 761 | 789 | 818 |
| 0.60 | 86 | 100 | 636 | 28 | 56 | 85 | 736 | 764 | 792 | 821 |
| 0.70 | 90 | 104 | 633 | 29 | 57 | 86 | 737 | 766 | 794 | 823 |
| 0.80 | 93 | 109 | 630 | 29 | 57 | 86 | 739 | 768 | 796 | 825 |
| 0.90 | 96 | 112 | 628 | 29 | 57 | 86 | 740 | 769 | 797 | 826 |
| 1.0 | 99 | 115 | 626 | 29 | 57 | 87 | 741 | 770 | 798 | 828 |
| 1.1 | 102 | 118 | 625 | 29 | 57 | 87 | 743 | 772 | 800 | 830 |
| 1.2 | 104 | 120 | 623 | 29 | 57 | 87 | 745 | 774 | 802 | 832 |
| 1.4 | 109 | 127 | 619 | 30 | 58 | 88 | 746 | 776 | 804 | 834 |
| 1.6 | 113 | 132 | 616 | 30 | 58 | 88 | 748 | 778 | 806 | 836 |
| 1.8 | 116 | 136 | 614 | 30 | 58 | 88 | 750 | 780 | 808 | 838 |
| 2.0 | 120 | 140 | 612 | 30 | 58 | 88 | 752 | 782 | 810 | 840 |
| 2.5 | 127 | 148 | 606 | 30 | 59 | 89 | 754 | 784 | 813 | 843 |
| 3.0 | 133 | 155 | 601 | 30 | 59 | 89 | 756 | 786 | 815 | 845 |
| 3.5 | 138 | 162 | 596 | 30 | 59 | 89 | 758 | 788 | 817 | 847 |
| 4.0 | 143 | 167 | 592 | 31 | 60 | 90 | 759 | 790 | 819 | 849 |
| 4.5 | 147 | 172 | 589 | 31 | 60 | 90 | 761 | 792 | 821 | 851 |
| 5.0 | 151 | 177 | 587 | 31 | 61 | 90 | 764 | 795 | 825 | 854 |
| 5.5 | 155 | 182 | 584 | 31 | 61 | 91 | 766 | 797 | 827 | 857 |
| 6.0 | 158 | 186 | 581 | 31 | 61 | 91 | 767 | 798 | 828 | 858 |
| 6.5 | 161 | 189 | 578 | 32 | 62 | 92 | 767 | 799 | 829 | 859 |
| 7.0 | 164 | 193 | 575 | 32 | 62 | 92 | 768 | 800 | 830 | 860 |
| 7.5 | 167 | 196 | 573 | 32 | 62 | 92 | 769 | 801 | 831 | 861 |
| 8.0 | 170 | 199 | 571 | 32 | 62 | 92 | 770 | 802 | 832 | 862 |
| 8.5 | 172 | 202 | 569 | 32 | 62 | 92 | 771 | 803 | 833 | 863 |
| 9.0 | 174 | 205 | 566 | 33 | 63 | 93 | 771 | 804 | 834 | 864 |
| 9.5 | 177 | 208 | 564 | 33 | 63 | 93 | 772 | 805 | 835 | 865 |
| 10.0 | 179 | 211 | 562 | 33 | 63 | 93 | 773 | 806 | 836 | 866 |
| 11.0 | 183 | 216 | 559 | 33 | 63 | 93 | 775 | 808 | 838 | 868 |
| 12.0 | 187 | 220 | 556 | 33 | 64 | 94 | 776 | 809 | 840 | 870 |
| 13.0 | 191 | 225 | 552 | 33 | 65 | 95 | 777 | 810 | 842 | 872 |
| 14.0 | 194 | 229 | 549 | 33 | 65 | 96 | 778 | 811 | 843 | 874 |
| 15.0 | 197 | 233 | 545 | 34 | 66 | 97 | 778 | 812 | 844 | 875 |
| 16.0 | 200 | 237 | 542 | 34 | 66 | 97 | 779 | 813 | 845 | 876 |
| 18.0 | 206 | 244 | 536 | 35 | 67 | 98 | 780 | 815 | 847 | 878 |
| 20.0 | 211 | 250 | 531 | 35 | 68 | 99 | 781 | 816 | 849 | 880 |

5. The specific heat of ice is 0.49. Consequently to convert one ton of ice at —8 degrees into water at zero degrees requires the application of 97.6 kilowatt-hours, this amount being accounted for as follows:

Four and six-tenths kilowatt-hours are required to raise the temperature of the ice to zero degrees, and ninety-three kilowatt-hours are required to liquefy the ice.

6. To convert one ton of ice at —8 degrees into water at +8 degrees requires the expenditure of 107 kilowatt-hours, this amount being accounted for as follows: As in Example 5, 97.6 kilowatt-hours are required to change the ice into water at zero degrees, and a further 9.3 kilowatt-hours to raise the temperature of the water to eight degrees.

7. The average specific heat of transformer oil is 0.75, of copper 0.1, of iron 0.11. In a certain transformer the weight of the copper is 100 kilogrammes, the laminations 200 kilogrammes, the cast-iron case 150 kilogrammes, and the oil 180 kilogrammes. The internal loss amounts to one kilowatt and it is required to find the time required to cause a rise of temperature of forty degrees, assuming that the heat is exclusively employed in causing a rise of temperature and that none is radiated from the external surface of the frame.

The oil requires $0.75 \times 1.16 \times 0.18 \times 40 = 6.3$ kilowatt-hours. Similarly the copper requires 0.46 kilowatt-hours, the laminations one kilowatt-hour, and the frame 0.75 kilowatt-hour. The total heat required is 8.5 kilowatt-hours, so that if the losses in the transformer are one kilowatt, the time would be 8.5 hours, under the conditions set forth.

**Energy Transformations.**

Electrical energy, or, briefly, electricity, can be transformed into work energy—or work with an efficiency as high as ninety-five per cent in large motors. Work may be trans-

## TABLE VI.

### Heat Energy in Kilowatt-Hours Rendered Available for Conversion into Mechanical Work by the Expansion of One Ton of Steam.

| Exhaust Pressure in Kg. per Sq. Cm. | Admission Pressure in Kg. per Sq. Cm. 16 | | | 14 | | | | 12 | | | | 10 | | | | 8 | | | | 7 | | | | Heat energy (in kw.-hr per ton) available for conversion into work. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Admission Temperature in Degrees Centigrade. | | | | | | | | | | | | | | | | | | | | | | | |
| | 200 | 250 | 300 | 194 | 200 | 250 | 300 | 187 | 200 | 250 | 300 | 179 | 200 | 250 | 300 | 170 | 200 | 250 | 300 | 158 | 200 | 250 | 300 | |
| 0.05 | 228 | 243 | 261 | 225 | 226 | 241 | 256 | 219 | 223 | 236 | 250 | 211 | 217 | 230 | 242 | 202 | 209 | 222 | 234 | 191 | 200 | 212 | 226 | |
| 0.1 | 210 | 224 | 240 | 205 | 208 | 220 | 238 | 199 | 204 | 215 | 238 | 190 | 197 | 208 | 222 | 180 | 188 | 199 | 214 | 170 | 179 | 190 | 203 | |
| 0.2 | 188 | 200 | 214 | 183 | 185 | 197 | 210 | 176 | 179 | 190 | 204 | 168 | 174 | 182 | 197 | 158 | 165 | 174 | 187 | 146 | 154 | 163 | 177 | |
| 0.4 | 162 | 175 | 188 | 158 | 154 | 172 | 183 | 151 | 153 | 165 | 176 | 144 | 148 | 157 | 169 | 133 | 139 | 148 | 160 | 122 | 129 | 137 | 150 | |
| 0.6 | 148 | 160 | 173 | 143 | 144 | 155 | 168 | 137 | 139 | 150 | 161 | 127 | 132 | 142 | 153 | 118 | 123 | 132 | 143 | 105 | 112 | 121 | 132 | |
| 0.8 | 138 | 147 | 160 | 132 | 132 | 144 | 154 | 125 | 128 | 138 | 147 | 117 | 120 | 130 | 140 | 107 | 111 | 120 | 130 | 95 | 100 | 108 | 120 | |
| 1.0 | 128 | 139 | 152 | 123 | 123 | 134 | 146 | 116 | 119 | 128 | 128 | 108 | 112 | 120 | 130 | 97 | 102 | 110 | 119 | 85 | 90 | 99 | 109 | |
| 1.5 | 114 | 122 | 133 | 106 | 108 | 118 | 128 | 100 | 102 | 111 | 120 | 91 | 94 | 102 | 111 | 80 | 83 | 92 | 101 | 67 | 72 | 79 | 90 | |

Note.—The values for steam initially saturated are set in heavier type.

## TABLE VII.

### Table of Specific Volume and Specific Weight of Saturated and Superheated Steam.

| Absolute Pressure in Kg. per Sq. Cm. | Temperature of Vaporization in Deg. Cent. | Specific Volume in Cu. M. per Kg. | | | | Specific Weight in Kg. per Cu. M. | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Saturated Steam | Steam Superheated 50 Deg. Cent. | Steam Superheated 100 Deg. Cent. | Steam Superheated 150 Deg. Cent. | Saturated Steam. | Steam Superheated 50 Deg. Cent. | Steam Superheated 100 Deg. Cent. | Steam Superheated 150 Deg. Cent. |
| A | B | N | O | P | Q | R | S | T | U |
| 0.02 | 17 | 68.0 | 81.0 | 93.0 | 105.0 | 0.015 | 0.012 | 0.011 | 0.010 |
| 0.04 | 29 | 35.0 | 42.0 | 48.0 | 54.0 | 0.028 | 0.024 | 0.021 | 0.019 |
| 0.06 | 36 | 24.0 | 28.0 | 32.0 | 36.0 | 0.042 | 0.036 | 0.031 | 0.028 |
| 0.08 | 41 | 18.0 | 21.0 | 24.0 | 27.0 | 0.055 | 0.047 | 0.041 | 0.037 |
| 0.10 | 46 | 15.0 | 17.0 | 20.0 | 22.0 | 0.066 | 0.058 | 0.051 | 0.046 |
| 0.12 | 49 | 12.0 | 15.0 | 17.0 | 19.0 | 0.081 | 0.069 | 0.061 | 0.054 |
| 0.15 | 54 | 10.0 | 12.0 | 13.0 | 15.0 | 0.100 | 0.085 | 0.075 | 0.067 |
| 0.20 | 60 | 8.0 | 9.0 | 10.0 | 11.0 | 0.130 | 0.112 | 0.099 | 0.089 |
| 0.25 | 65 | 6.4 | 7.3 | 8.3 | 9.2 | 0.16 | 0.14 | 0.12 | 0.11 |
| 0.30 | 69 | 5.3 | 6.1 | 6.9 | 7.7 | 0.19 | 0.16 | 0.14 | 0.13 |
| 0.35 | 72 | 4.6 | 5.3 | 6.0 | 6.6 | 0.22 | 0.19 | 0.17 | 0.15 |
| 0.40 | 76 | 4.0 | 4.6 | 5.3 | 5.9 | 0.25 | 0.22 | 0.19 | 0.17 |
| 0.50 | 81 | 3.3 | 3.8 | 4.3 | 4.7 | 0.31 | 0.26 | 0.24 | 0.21 |
| 0.60 | 86 | 2.8 | 3.2 | 3.6 | 4.0 | 0.36 | 0.31 | 0.28 | 0.25 |
| 0.70 | 90 | 2.4 | 2.8 | 3.1 | 3.4 | 0.42 | 0.36 | 0.32 | 0.29 |
| 0.80 | 93 | 2.1 | 2.4 | 2.7 | 3.0 | 0.48 | 0.41 | 0.37 | 0.33 |
| 0.90 | 96 | 1.9 | 2.2 | 2.4 | 2.7 | 0.53 | 0.46 | 0.41 | 0.37 |
| 1.0 | 99 | 1.7 | 2.0 | 2.2 | 2.4 | 0.59 | 0.51 | 0.45 | 0.41 |
| 1.1 | 102 | 1.6 | 1.8 | 2.0 | 2.2 | 0.64 | 0.56 | 0.50 | 0.45 |
| 1.2 | 104 | 1.4 | 1.7 | 1.9 | 2.1 | 0.70 | 0.60 | 0.54 | 0.49 |
| 1.4 | 109 | 1.2 | 1.4 | 1.6 | 1.8 | 0.80 | 0.70 | 0.63 | 0.57 |
| 1.6 | 113 | 1.1 | 1.3 | 1.4 | 1.6 | 0.92 | 0.79 | 0.71 | 0.64 |
| 1.8 | 116 | 1.0 | 1.1 | 1.3 | 1.4 | 1.02 | 0.89 | 0.80 | 0.71 |
| 2.0 | 120 | 0.89 | 1.02 | 1.14 | 1.26 | 1.1 | 1.0 | 0.9 | 0.8 |
| 2.5 | 127 | 0.72 | 0.83 | 0.93 | 1.02 | 1.4 | 1.2 | 1.1 | 1.0 |
| 3.0 | 133 | 0.61 | 0.70 | 0.78 | 0.86 | 1.6 | 1.4 | 1.3 | 1.2 |
| 3.5 | 138 | 0.52 | 0.60 | 0.68 | 0.74 | 1.9 | 1.7 | 1.5 | 1.4 |
| 4.0 | 143 | 0.46 | 0.53 | 0.59 | 0.67 | 2.2 | 1.9 | 1.7 | 1.5 |
| 4.5 | 147 | 0.43 | 0.47 | 0.53 | 0.58 | 2.4 | 2.1 | 1.9 | 1.7 |
| 5.0 | 151 | 0.37 | 0.43 | 0.47 | 0.52 | 2.7 | 2.3 | 2.1 | 1.9 |
| 5.5 | 155 | 0.34 | 0.39 | 0.44 | 0.48 | 2.9 | 2.5 | 2.3 | 2.1 |
| 6.0 | 158 | 0.32 | 0.36 | 0.40 | 0.44 | 3.2 | 2.8 | 2.5 | 2.3 |
| 6.5 | 161 | 0.29 | 0.34 | 0.37 | 0.41 | 3.4 | 3.0 | 2.7 | 2.5 |
| 7.0 | 164 | 0.27 | 0.31 | 0.35 | 0.38 | 3.7 | 3.2 | 2.9 | 2.6 |
| 7.5 | 167 | 0.26 | 0.29 | 0.32 | 0.35 | 3.9 | 3.4 | 3.1 | 2.8 |
| 8.0 | 170 | 0.24 | 0.28 | 0.30 | 0.33 | 4.1 | 3.5 | 3.3 | 3.0 |
| 8.5 | 172 | 0.23 | 0.26 | 0.29 | 0.31 | 4.4 | 3.8 | 3.5 | 3.2 |
| 9.0 | 174 | 0.22 | 0.24 | 0.27 | 0.30 | 4.6 | 4.1 | 3.7 | 3.4 |
| 9.5 | 177 | 0.21 | 0.23 | 0.26 | 0.28 | 4.9 | 4.3 | 3.9 | 3.6 |
| 10.0 | 179 | 0.20 | 0.22 | 0.24 | 0.27 | 5.1 | 4.6 | 4.1 | 3.8 |
| 11.0 | 183 | 0.18 | 0.20 | 0.22 | 0.24 | 5.6 | 5.0 | 4.5 | 4.1 |
| 12.0 | 187 | 0.16 | 0.18 | 0.20 | 0.22 | 6.1 | 5.4 | 4.9 | 4.5 |
| 13.0 | 191 | 0.15 | 0.17 | 0.19 | 0.21 | 6.5 | 5.9 | 5.3 | 4.8 |
| 14.0 | 194 | 0.14 | 0.16 | 0.18 | 0.19 | 7.0 | 6.4 | 5.7 | 5.2 |
| 15.0 | 197 | 0.13 | 0.15 | 0.16 | 0.18 | 7.5 | 6.8 | 6.1 | 5.6 |
| 16.0 | 200 | 0.12 | 0.14 | 0.15 | 0.17 | 7.9 | 7.3 | 6.6 | 6.0 |
| 18.0 | 206 | 0.11 | 0.12 | 0.14 | 0.15 | 8.9 | 8.2 | 7.4 | 6.8 |
| 20.0 | 211 | 0.10 | 0.11 | 0.13 | 0.14 | 9.6 | 8.9 | 8.1 | 7.5 |

formed into electricity with equally high efficiency. The remaining five per cent or more is converted into heat energy or, briefly, into heat. Electricity and work may both be converted into heat with an efficiency of 100 per cent. Thus if an electric current is sent through a resistance, the electrical energy is entirely converted into heat in the resistance. If work is performed in stirring water, as in Joule's experiment, the work energy may be entirely transformed into heat energy. The "generation" of electrical energy in generating stations is strictly the transformation of energy from heat to electricity.

(To be continued.)

## UNITED STATES GEOLOGICAL SURVEY HYDROGRAPHIC INVESTIGATIONS.

The United States Geological Survey, in connection with its other activities, has been engaged for the past twelve years in making investigations of the quantity, quality and availability of surface and ground water throughout the United States. The results of these investigations have been published regularly as Water Supply and Irrigation Papers, and have been available for distribution and for reference in libraries throughout the country. The importance of this work and the value to the public of a knowledge of our water resources has led some of the States, private individuals and corporations to co-operate with the Survey in securing the desired information, and the results of many independent measurements and investigations have been placed at the disposal of the Survey and made available for general use by their publication, with the results of the investigations made by the Survey in the Water Supply and Irrigation Papers. The value of this information is by no means limited to the communities in which actual observations are made, as the intelligent study of water yield in various parts of the country under known conditions of precipitation, temperature, altitude, topography and cultivation affords a basis for at least approximate determination of the water resources of other localities where no direct investigations have been made, and if the hydrographic investigations are continued throughout the country under the uniform methods and skilled direction of the Geological Survey, it may ultimately become possible, with the accumulated data covering seasonal and cyclic variations in stream flow, to formulate general laws which will permit a determination of the water yield in localities where the water resources have not been investigated, from the meteorological records of the United States Weather Bureau, and a knowledge of the topography, extent and nature of cultivation and other factors which are readily ascertained.

It hardly seems necessary to draw attention to the absolute impossibility of developing any part of the country without an adequate supply of water of suitable quality. For domestic purposes, for irrigation, for every class of industrial enterprise, a determination of the availability of an ample water supply is the first consideration. We have never heard any question raised concerning the importance of these hydrographic investigations, their value to the people, nor the thoroughness with which the Survey has done its work, within the limitations of the funds available.

These investigations have been continued during the past twelve years, and the appropriations therefor were gradually increased by Congress to $200,000 per annum, which amount was available for four years prior to June 30, 1906. The Committee on Appropriations of the House (59th Congress, 2d Session) disapproved of this work, and claimed that it had no Federal purpose, and should not, therefore, be supported by the Federal Government. The Chairman of the Committee stated that "I do not take issue with the advocates of this appropriation on the question of benefit to the people. The issue which I raise with them is the question of whose duty it is to perform the work." This Committee, in reporting the Sundry Civil bill, made no provision for this work for the year ending June 30, 1907. An attempt was made on the floor of the House to introduce an amendment, the result of which would have been to provide a suitable appropriation, but a point of order was raised and sustained.

The Senate later approved an appropriation of $150,000 which, in conference between the Committees of both branches, was reduced to $100,000, and the Survey has, therefore, been obliged to carry on the work during the present year for half the amount previously available. The amount of work performed has been proportionately reduced.

In regard to the point of order sustained in the House, it was alleged that the organic act of the Geological Survey does not make any provision for these investigations, and that, therefore, any appropriation for same is without authority in law, notwithstanding the fact that the work has been continued over a period of twelve years under appropriations of Congress.

The Secretary of the Interior has included in his estimate for the year ending June 30, 1909, the sum of $200,000 for hydrographic investigations of the United States Geological Survey. The attitude of the members of the present Committee on Appropriations on this subject is not known to us, but in view of the precedent established on the point of order at the last session it is manifestly desirable that a bill be passed giving the Survey specific authority to continue these hydrographic investigations, before the appropriation bill comes up for action.

Such a bill (House Bill No. 6122) was introduced on December 9th by Mr. Needham, "to provide for continuation of investigations of the rivers and water resources of the United States," and will presumably be passed upon by the Rivers and Harbors Committee early in January, and soon after acted upon by the House. If this bill is passed there will be no possible legal objections to the appropriation for hydrographic investigations in the Sundry Civil bill, and the item may then be considered by Congress solely upon its merits when this Appropriation bill is taken up later in the session.

"It is manifestly impossible for any individual investigators or corporations to pursue such an extended series of gaugings and studies of the laws governing the water resources of the United States, as is necessary to establish the relations between rainfall, evaporation, temperature ranges and other climatic conditions affecting the water yield of drainage basins in different parts of the country, and where such local investigations are made by private enterprise the information secured does not ordinarily become available to the interested public, except indeed when the data is communicated to the Geological Survey, and combined with the results of their own work in the publication of Water Supply and Irrigation Papers.

"It is equally impracticable for the several States to thoroughly cover these investigations, as there would be such lack of uniformity in methods as to prevent the general application of the data thus independently collected, and in the case of the larger streams which bound or traverse several States the net results would probably be so confusing as to be unsafe for practical use.

"The increasing development of all the natural resources of the country is of course desirable, but in the case of water, which is indispensable to the prosperity and even the existence of every community, the most complete knowledge should be available in order that it may be intelligently and effectively conserved and utilized for power, for irrigation and for municipal water supplies."

This is properly a Federal undertaking, equally with the maintenance of the Weather Bureau, the control of navigable rivers, the institution of forest reserves, the surveying and mapping of the United States and other public works which cannot effectively be undertaken by individuals or the several States. We trust that Congress will appreciate the real value and propriety of this Federal undertaking and the seriousness of even a temporary interruption of the consecutive observations, which are essential to the proper conduct of the work, and that House bill No. 6122 may be favorably reported by the Rivers and Harbors Committee, become law, and that the requested item of $200,000 in the Sundry Civil bill may be favorably reported, and this appropriation thus again become available.

## CURRENT COMMENT

An electric forge for sharpening drills is being tested underground at one of the South African mines. If successful, it will avoid overheating and burning the steel, and save the expense and delay of carrying the drills to the surface for sharpening, as well as eliminating smoke.

Any direct current series motor will run with alternating current if undue heating is prevented by proper design of the magnetic field. Sparking caused by the alternating field flux is reduced to a minimum by inserting resistance in the leads between the armature and the commutator segments.

It is claimed that celluloid for accumulator cells can be made incombustible by dissolving it in acetone and, after treatment with phosphate of iron or other salts, adding tetrachloride of carbon and formaldehyde. The celluloid floating on the surface may be dried and molded without any change in its original properties except its inflammability.

The electric furnace at Heroult, Shasta County, Cal., owned by the Noble Electric Steel Company, will be devoted to the production of ferro-silicon and other ferro alloys. D. A. Lyon has recently been appointed general manager for the company, and will be in charge of these operations. Preliminary runs that have been made, have been very successful so far as the economies and the quality of the production is concerned.

A press dispatch from Paris states that Pascal Berjonneau, an inventor, has exhibited before the Postmaster-General and a number of persons interested in scientific investigation a new telephotography apparatus which can be adapted to the wireless system or to the ordinary telegraph wires. He transmitted the picture of the Postmaster-General without the aid of wires from one end of the hall to the other. The inventor claims that distance does not interfere with the effectiveness of his method. Photographs, he says, can be sent by it between New York and Paris.

A new system for the fixation of atmospheric nitrogen devised by A. Moschi uses an arc magnetically deviated. The arc is produced between two concentric carbon rings which act as electrodes. By means of a magnetic field perpendicular to the plane of the rings the arc is deflected and is caused to rotate within the annular space between the two rings. This system is said to have yielded 525 kg. of nitric acid per kw-year. The same method was also used in experiments of Brion, while the Badische Anilin und Soda Fabrik uses a quiet continuous arc several meters in length inclosed within a tube of suitable diameter, the air being passed through the tube from one end to the other. The specific yield of nitric acid is stated to be higher with this arrangement than with the Birkeland-Eyde process.

W. L. Saunders, in a paper presented before the American Institute of Mining Engineers, claims that the electric air drill takes from one-third to one-fourth of the power, at the power house, to drive it to do the same work as a simple pneumatic drill. This is accounted for by the fact that the same air is used over and over, and that all of its elastic force is availed of in both directions, instead of exhausting the charge for each stroke at full pressure. There are also no large clearance-spaces to fill anew at each stroke, as these spaces are never emptied. A valuable feature of the electric air drill is the ability to yank the bit free if stuck in a hole and immediately continue its work. At Idaho Springs, Colo., a mine shaft was put down 67 feet in 24 shifts and the total energy cost was $24.00 for the entire work.

Siemens & Halske have been granted a patent for producing homogeneous bodies from tantalum and other highly refractory metals, which consists in heating the oxide in vacuum in an electric furnace, and subjecting the metal to the influence of an electric arc. To produce a plastic mass with wolfram combinations having adhesive properties like those of glue, and which can easily be drawn out in threads, acid ammonium wolframate is heated to dryness in a vessel to obtain disengagement of ammonia. Heating should not be too great, to avoid greater decomposition. The temperature should preferably be below redness—e. g., about 270 degs. C. Heating is continued until the mass acquires a greenish-grey tint, which disappears in cooling, and until no more ammonia is disengaged. The product thus obtained forms, in hot water or after a little boiling in water, a tenacious substance like glue, which can be drawn out in threads, if too much water has not been employed. The threads thus obtained can be profitably used for electric incandescent lamps. When the acid ammonium wolframate is heated in a retort it is well to remove all air by producing an almost complete vacuum in the retort. The material thus produced is very useful as a binding substance for wolfram oxides.

All of the 130 miles of street railway in St. Petersburg are to be electrified within the next six years. The first section, thirty miles in length, has been finished by the Westinghouse Company. For operating this section of the lines a central station has been located upon the Obvodny Canal, where it can receive coal from barges. Three turbine-alternator units placed in the dynamo room, operate at 1,500 revolutions per minute and are rated at 2,200 kilowatts, delivering 6,600 volts at twenty-five cycles. The boiler room contains six double boilers, and the plant is also equipped with a battery of 130 cells of accumulators. Five substations are used for the line, and each of these will have a capacity of 1,000 or 2,250 kilowatts, according to its location. In the substations are installed a set of oil transformers which receive the main current from the central station at 6,600 volts. At the secondaries of the transformers the voltage is 370 volts three-phase. This is used upon rotary converters which supply direct current at 600 volts for the trolley wire. Different capacities, either 500 or 150 kilowatts, are used for the rotaries, and the machines are started up by a small three-phase motor, or else a storage battery which the station contains can be used for starting if need be. The rolling stock used upon the first section consists of 200 motor cars. Each of the cars is fitted with two forty-horse-power motors. The old horse cars may be used as trailers.

### MEETING NOTICE.

The Illuminating Engineering Society, at its meeting of December 18, 1907, was addressed by Prof. Puffer, who presented an interesting paper on "The Variables of Illuminating Engineering." Considerable discussion followed, participated in by Prof. Puffer, Prof. Clifford, Dr. Bell, Messrs. Campbell, Codman, Hatch, Ware, Curry and others.

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Builders' News

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VOL. XX JANUARY 4, 1908 No. 1

## EDITORIAL.

**PACIFIC POWER REVIEW.**

Throughout the whole country this week almost every business man is "taking stock." As this summing up of possessions and elimination of shelf-worn articles is necessary for the successful conduct of every business, so is it of use in understanding our status in engineering development. But while the custom may be commendable, the time most certainly is not auspicious. At the end of the calendar year the statistician is unable to present his complete report, and the reviewer lacks the definite data from which to gain the requisite mental perspective. Even the advantage of intimate acquaintance is not compensating. Necessarily, taking a worm's-eye view of affairs with which we are in closest contact, there is likelihood of our being dazzled by the spectacular advance made in the development of wireless transmission, new incandescent filaments and their ilk, without sensing the steadier illumination produced by the aggregate of more practical and efficient units. Yet this comparison of lines of development is itself comparative, and the introduction of a new function in the variable often reverses its significance. Time's integration will show the unfit of today to be the fit of tomorrow. For the past decade the backers of hydraulic turbines, reciprocating steam engines, gas engines and dynamos have been disputing the relative merits of their machines without reference to the fact that while certain conditions may make one form of motive power far superior to another, yet under different conditions the supremacy is alternated.

There is probably no more notable advance in the face of contending odds than that shown by the upbuilding of the steam turbine. So great has been the effort of brain, brawn and money expended upon this problem, that it has materially weakened the body of the corporation, and some even hint that the succumbing of some of the large manufacturers to the recent financial epidemic was in part due to the attempts to bring forth a commercial steam turbine. But owing to their great recuperative powers, recovery has been rapid, and as a result we now have several types in successful operation.

One strong factor in continued growth of both the turbine and reciprocating engine has been the increased knowledge of the uses and advantages of superheated steam, which, during the past year, has resulted in several changes in engine design with promise of increased efficiency. Steam boilers are undeniably susceptible of great improvement, and this year it has been announced by a competent authority that he can produce ten times the amount of steam at present obtained per square foot of heating surface. This is to be done by improving the combustion chamber as a burner of volatile matter. The steam engine is undoubtedly the most reliable prime mover, working for years without losing a week's time, and still showing the same economy as when first installed. This freedom from breakdown and its sustained efficiency will indefinitely postpone its predicted extinction.

Undoubtedly, much of the improved efficiency of the older forms of power has been caused by the competition of the gas engine with its greater thermal efficiency. There is nothing like the spur of competition to cause improvement in hitherto dormant bodies. The past year has shown that most of the gas engine troubles are due to ignorance of the best working condition. It is often required to work at all sorts of speed, with a great variety of mixtures, and variable points of ignition, together with imperfect elimination of waste products. In a recent paper, Professor Lucke proposes a smooth interior for the ignition chamber with a free entrance for a uniform gaseous mixture regularly supplied, as the best means of averting these troubles. The gas engine is far from perfect yet, but even now it is capable of furnishing power at a low cost. Especially is this true with producer gas, which, though it has received no great development in this country, shows wonderful possibilities as an agent for power, light and heat distribution. The success of the great oil pipe lines in California suggests the possibilities of power by gas over long distances.

Already the largest oil gas plant in the world has been constructed south of San Francisco, in San Mateo County, and, besides supplying gas to the large engines there, the gas is also transmitted twenty-four miles to Redwood City, and four and a half miles to one of the stations of the San Francisco Gas & Electric Company, from which it is delivered

throughout the city. Two compressors, each having a capacity of 5,500,000 cubic feet of gas in twenty-four hours, compress the gas to from fifty to sixty pounds per square inch. This work is somewhat similar to that accomplished years ago by the natural gas men, and it is to them that the progressive gas engineer of today is looking for solution hints. The transmission pipe could be made of any length provided that compressors were placed at suitable points on the line to drive the gas through the next section. The attractive possibilities of extensive gas transmission affords a fertile field for an active imagination.

The claim that the gas engine is applicable only to small units is refuted by the success of the greatest gas engine plant of the world, that of the California Gas & Electric Corporation, at Martin Station. Three engines have each been producing 3,200 kilowatts per hour for from ten to twenty-four hours per day since January, 1907, and have a full capacity of 4,000 kilowatts apiece. They have operated in parallel with all the power plants of the corporation, primarily furnishing current for the street railroads of San Francisco. One of these great engines standing cold and inert as a power potential, can be converted into a pulsating power producer in just one minute's time. When fuel economy is desired the gas engine's pre-eminence is assured.

But for universal use it is found that the electric motor is more convenient and flexible than even the gas engine, and this rapid age awards the palm to it. The factor of economy is introduced by water. For of the two fundamental power sources, fuel and water, the latter is the cheaper, and also the more lasting. So uniform has been the advance along the lines of hydro-electricity recently that it is hard to differentiate any one achievement as more notable than another, but we of the West are today marveling over the performance of a 9,700-horsepower Francis turbine at the Centerville plant of the Bay Counties Power Company. Never before has a Francis turbine been designed for so high a head as 550 feet.

But this essay is not intended as a discussion of the relative merits of these various methods of power development and transmission. The most enthusiastic engineer recognizes that no one of them should be applied to every time and place, that one must often supplement the other, and that all together they are aiming to make an integral whole, all necessary, all inter-related. Correct conclusions cannot be deduced where there is fear of a rival's success, hate of his personality and prejudice against his product. The deeds of the past are but incentives for the doers of the future, and in the year now before us we can predict even greater strides toward perfection, which we are approaching even as the hyperbola approaches its assymptotes. We can avoid unstable equilibrium only by progressive motion, and for that we have "that best and most precious of inspirations—the inspiration of things to do and of things undone—the inspiration of big jobs."

## TRADE CATALOGUES.

The Dean Gas Engine and Foundry Co., of Newport, Kentucky, send an interesting catalog of the Dean engines, gas, gasoline, alcohol and distillate. This catalog gives the bow and stroke of the cylinders, and the capacity in cubic inches. Net prices are given.

In bulletin No. 4550, the General Electric Company, Schenectady, N. Y., describes several carbon break circuit breakers. Type C, form G circuit breakers are designed for a small, reliable, automatic, protective device for direct and alternating current systems, at a moderate price. Type C, form P, are particularly adapted for use on railway and power systems which are frequently subjected to severe short circuits and heavy overload. They are made up to 12,000-ampere capacity. Type C, form K, especially designed for heavy service, are particularly well suited for railway work. They are made in capacities up to 10,000 amperes. The bulletin also contains descriptions of auxiliary switches, automatic tripping devices, etc., to be used with the circuit breakers, and gives complete data as to capacities, prices and dimensions of the devices shown. The bulletin contains thirty-six pages and is conveniently arranged for reference.

Bulletin No. 4551, recently issued by the General Electric Company, illustrates and describes the various types of Thomson horizontal edgewise instruments, giving dimension sketches and a complete set of full-sized scales. The watt-meters, power-factor indicators and frequency indicators are constructed on the direct-reading dynamotor principle; the ammeters and voltmeters on the Thomson inclined coil principle. All the instruments are of uniform size, thus giving a pleasing appearance when installed. The horizontal edgewise design has been adopted for the majority of high-grade work since it was first introduced some years ago. While primarily designed for alternating-current service, the voltmeters, ammeters and wattmeters can be used with good results on direct current.

## PERSONAL.

Mr. Wm. Hewitt, of the Hewitt Machinery Co., has returned to San Francisco after an extensive trip throughout the East.

H. W. Johnson, general manager of the Similkameen Power Company, has returned to Oroville, Wash., after an extended trip East.

C. M. Hobbs has retired as general manager of the Nevada-California Power Company, operating at Tonopah and Goldfield. Delos A. Campbell, the recently elected president, assumes the general management.

Walter M. Fagan is leaving San Francisco to take charge of the Los Angeles office of the Telephone & Electric Equipment Company. H. E. Bittman of Los Angeles has been transferred to the San Francisco office.

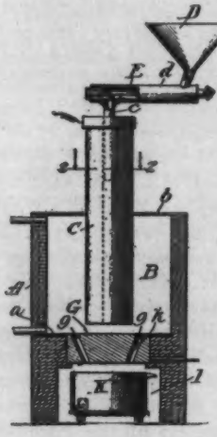
Carl H. Holley has resigned as general superintendent and chief engineer of the Mt. Whitney Power Co., and will open offices in Visalia, California, with H. H. Holley, as electrical and irrigation engineers.

The next monthly meeting of the American Society of Mechanical Engineers will be held Tuesday evening, January 14, in assembly room No. 1, of the Engineering Societies' Building, at 29 West Thirty-ninth Street, New York. The subject will be "Car Lighting," the presentation being made by Mr. R. M. Dixon, president of the Safety Car Heating and Lighting Company, and will treat of the general subject of light of trains, showing relative economies in the several systems, electric and gas. There will be in operation exhibits of different methods, such as the Pintsch mantle, the vapor mantle system, a new acetylene system, and several varieties of axle lighting by electricity, with their regulating and governing mechanism.

# PATENTS

ELECTRIC SMELTING-FURNACE. 873,890. William R. Parks, Chicago, Ill., assignor to Samuel Shaw Parks, Chicago, Ill.

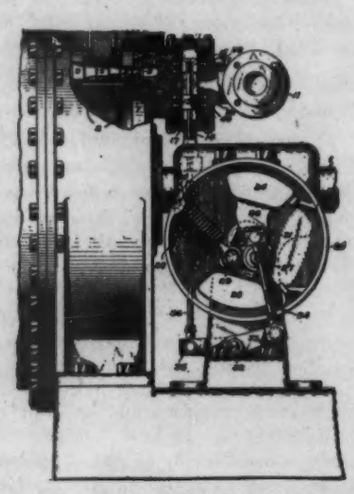
In an electric furnace, the combination with a tubular positive electrode, of a negative electrode having a circular



gutter in its upper surface concentric with the axis of positive electrode, and having a series of drains leading from said gutter, the lower openings of which converge toward the axis of negative electrode.

GOVERNING MECHANISM FOR TURBINES. 873,243. Oscar Junggren, Schenectady, N. Y., assignor to General Electric Company.

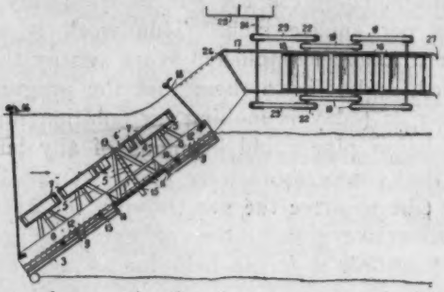
An elastic-fluid turbine having wheel buckets and independent fluid-admitting devices, in combination with a valve having a constant to-and-fro movement varying in amplitude with the load, that is common to the devices to regulate the passage of a motive fluid to the devices, and is interposed be-



tween them and the source of fluid supply, a governor responding to changes in load on the turbine, a member carried by and rotating with the governor weight whose orbit enlarges and diminishes as the load changes, and a connection which transforms the rotary motion of the member into a to-and-fro motion of the valve and also changes the amplitude of its movement with changes in size of the orbit of the member.

PORTABLE POWER-DAM. 873,845. William H. Crow, Pueblo, Colo.

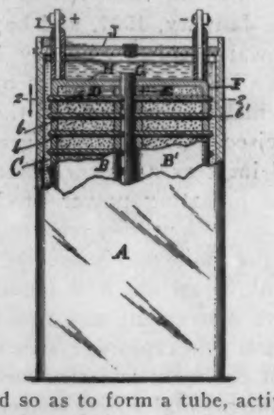
In a portable dam, longitudinally arranged timbers spaced



at a distance from each other, braces connected with timbers, floats at the forward end of braces, and vertically movable plank passed through the space between two timbers.

ELECTRICAL ACCUMULATOR. 873,715. Charles Busch, New York, N. Y.

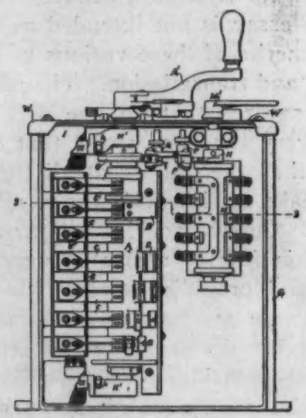
In an electrical accumulator, an element consisting of a metallic envelop formed of a sheet of substantially non-cor-



rosive metal folded so as to form a tube, active material contained within the tube and the ends of the envelop folded in so as to inclose the active material, perforations in the walls of the envelop and a capillary lacing passing through the perforations and uniting the opposite walls in the manner of a sinuous winding.

CONTROLLER. 873,805. Emmett W. Stull, Norwood, Ohio, assignor to Allis-Chalmers Company, a corporation of New Jersey, and The Bullock Electrical Manufacturing Company, a corporation of Ohio.

In a controller, a controlling drum, a shaft of magnetic

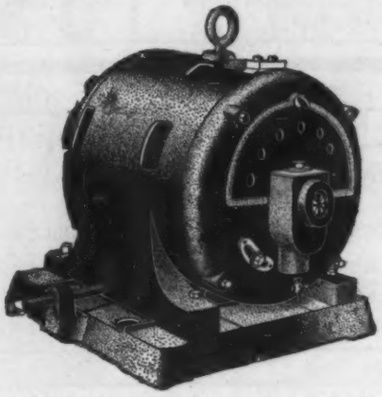


material therefor, a plurality of blowout magnets outside of the drum and having the controller shaft as part of the magnetic circuit, and plugs of magnetic material inserted in controlling drum adjacent to the circuit-breaking points of the controller.

# INDUSTRIAL

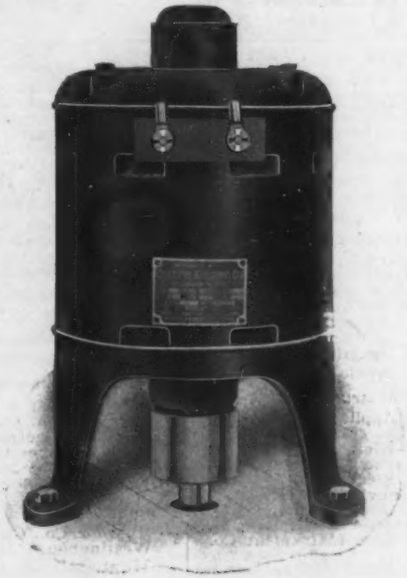
## SINGLE PHASE MOTORS.

The recognition among central station engineers and managers of the many advantages and economies of the single phase motors up to certain sizes (see article "Journal," December 21st) has led to such an increased demand for a perfect operating, durable single phase motor that the Century Electric Co., of St. Louis, Mo., has not only been compelled to increase its factory three times in as many years, but the demand for sizes larger than five horsepower has caused Mr. E. S. Pillsbury, vice-president and engineer of the company, to develop a 7½ and 10 horsepower, which tests show to give the best performance in point of efficiency, starting torque, over-



load capacity, and high power factor of any single phase motor yet tested.

The Century Electric Company, through Mr. Pillsbury, has confined its entire efforts to the manufacture and perfection of single phase motors only, and has many fundamental patents, as well as patents on improvement of detail, which, embodied in the "Century" motor, really places them beyond comparison



with any competitor.

Inspection instantly reveals a sturdy frame, completely protecting the winding, yet sufficiently ventilated to keep the rise in temperature of the warmest part below 40 degrees C.

The distributed wound stator, the terminal board and posts for changing the motors for operation on either 104 or 208 volts, the large shaft and liberal bearings and oil receptacles are noteworthy points. These motors are purely induction motors, self-starting under 25 per cent overload without condenser, compensating transformer, phase coils, clutches, or clutch pulleys. There is no moving wire in the rotor that is in any way connected to the line current, which makes it possible to so insulate the windings as to minimize the danger of breakdowns.

These motors are adapted to the operation of any kind of machinery, not requiring extremely frequent stopping and starting, or speed variation through the motor. For operating of irrigating or house pumps and compressors, refrigerating machines arranged for automatic starting and stopping by pressure or float switches, their action is ideal, and no attention is necessary. They are constructed for mounting on floor, wall or ceiling, and are easily reversed in direction of rotation. A non-inductive starter for use in series with the motors is provided for limiting the starting current, and raising the power factor when conditions render it advisable.

The district sales agents, the Standard Electrical Works, at 117 to 121 New Montgomery Street, San Francisco, Cal., have a full line of these motors, ½ to 10 horsepower, inclusive, in stock for frequencies of 50 and 60 cycles standard speed; also the ½ horsepower variable speed for operating printing presses, etc., where speed control of 50 per cent or less is required. They report the demand constantly increasing, and perfect satisfaction from their many customers scattered over the entire Coast. Ask for Bulletin No. 9, and prices.

## CIVIL SERVICE EXAMINATIONS.

The United States Civil Service Commission announces an examination on January 15, 1908, to secure eligibles to fill vacancies in the position of electrical assistant in the Signal Service at Large, at $900 per annum each, with prospects of promotion to $1,400 per annum. The examination will consist of practical questions in electrical science and in construction and installation of electrical instruments. Applicants should be thoroughly familiar with the practical side of electricity as applied to telegraph, telephone, and cable engineering, and also with the methods of testing and installing electrical instruments used in fire control, such as storage batteries, motor generators, power and telephone switchboards, wireless telegraph apparatus, telegraphs, electric clocks, telephones, etc.

An examination will be held on January 22, 1908, to fill two vacancies in the position of assistant engineer of tests in the testing laboratory at Watertown Arsenal, Mass., at $1,200 per annum each. The examination will consist of applied mechanics, strength of materials, testing apparatus and methods, and experience in manipulation and test making (rated on application). Applicants should give in their applications a clear, complete, and detailed account of their experience in the manipulation of testing machines and in the making of tests, stating every detail in proper order of time and omitting nothing that may enable the examiner to form a correct estimate of the value of their experience. Only those who show in their applications that they have received a good theoretical or practical training in civil or mechanical engineering and who, in addition thereto, show in their applications that they have had practical experience in manipulation of material-testing machinery will be admitted to the examination.

On January 22, 1908, to fill a vacancy in the position of teacher of mechanical drawing (male or female), at $600 per annum, Carlisle School, Pa., and vacancies requiring similar qualifications as they may occur in the Indian Service, an examination will be held in arithmetic and computations (including decimals and simple mechanical computations), drawing and shading (including a finished mechanical drawing made from rough sketch and showing shade and section lines), drawings and specifications (including the making from sketch and description of a finished drawing for photo-lithographic reproduction).

## FINANCIAL.

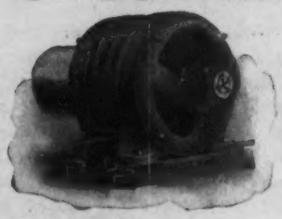
Porterville.—Assessment No. 8 of $10 per share has been levied on the Copo De Oro Water Company, delinquent January 1st.

Lemoore, Cal.—A special meeting of the stockholders of the Tres-Sierritas Oil & Mining Company will be held soon to consider diminishing the capital stock.

Vallejo.—The Board of Public Works has recommended to the City Trustees that immediate steps be taken to call a special election at which the people of Vallejo shall be given an opportunity to vote on the advisability of bonding the city for an additional $60,000 for a municipal water system.

Redwood City.—The mass meeting of Redwood City citizens for the consideration of a bond issue has been held. It was decided that $30,000 was needed, which should be divided as follows: $10,000 for a city hall, $15,000 for three steel water tanks, and $5,000 for water pipe.


C-W Induction Motors



are built by a company that has been satisfying its customers since 1888.

*See bulletin 88P.*

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Johns-Manville Co., H. W.

**Electrical Instruments**
Electric Appliance Co.
Cutter Co., The
Century-Klein Electric Co.
Fort Wayne Electric Works
General Electric Co.
Johns-Manville Co., H. W.
Tel. and Elec. Equipment Co.
Westinghouse Elec. & Mfg. Co.
Weston Elec. Instrument Co.

**Electrical Machinery**
Crocker-Wheeler Co.
California Electrical Works
Electric Appliance Co.
General Electric Co.
Northern Electrical Mfg. Co.
Standard Electrical Works
Century-Klein Electric Co.

**Electric Polishers**
Northern Electric Mfg. Co.

**Electric Railway Appliances**
Pierson, Roeding & Co.
General Electric Co.
Johns-Manville Co., H. W.

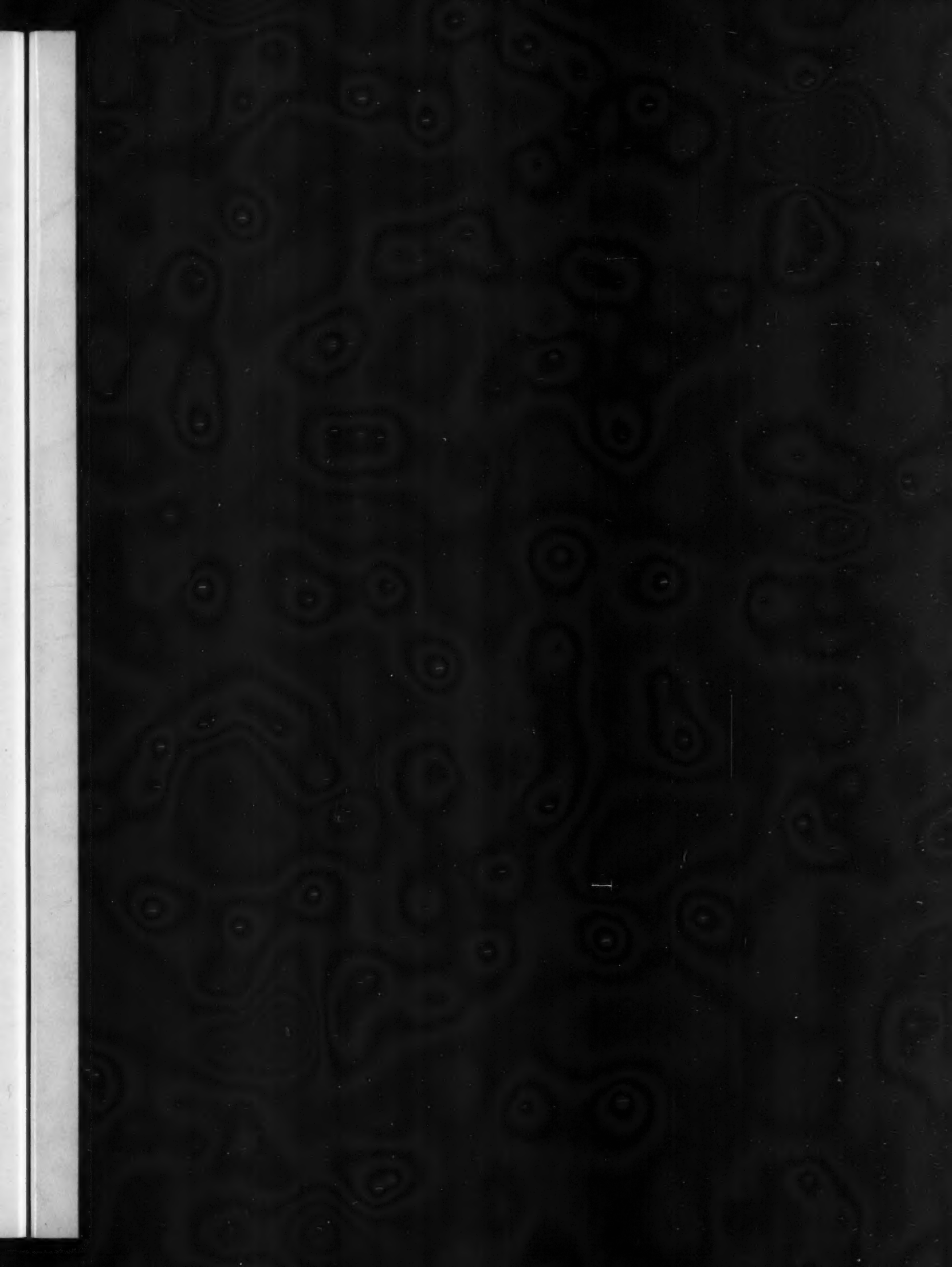
**Electrical Supplies**
California Electrical Works
Century-Klein Electric Co.
Electric Appliance Co.
General Electric Co.
Standard Electrical Works
Johns-Manville Co., H. W.
Tel. and Elec. Equipment Co.

**Electric Ventilating Fans**
Century-Klein Electric Co.
California Electrical Works
General Electric Co.
Northern Electrical Mfg. Co.

**Engines, Boilers, Heaters, etc.**
Moore, Chas. C. Co., Inc.

**Electric Watchman's Clocks**
Tel. and Elec. Equipment Co.

**Engineers, Chemical**
Smith, Emery & Co.
Moore & Co., Chas. C., Inc.
Standard Electrical Works
Tracy Engineering Co.
Westinghouse Machine Co.
Hunt, Mirk & Co.

**Engines, Gas and Gasoline**
Moore & Co., Chas. C., Inc.
Westinghouse Machine Co.
Hunt, Mirk & Co.

**Engineers and Contractors**
Brooks-Follis Elec. Corporat'n
Byllesby & Co., H. M.
California Electrical Works
Cannon, Edward F.
Hunt, Mirk & Co.
Century-Klein Co.
Copeland, Clem A.
Cory, C. L.
General Electric Co.
Hunt, Dillman, Meredith & Allen
Jackson, D. C. & W. B.
Smith, Emery & Co.